編號： 191 國立成功大學 109 學年度碩士班招生考試試題

系　　所：電腦與通信工程研究所

考試科目：電磁場與波　　考試日期：0211，節次：2

※ 考生請注意：本試題可使用計算機。　請於答案卷(卡)作答，於本試題紙上作答者，不予計分。

Problem 1 (20 Points)

The *relative permeability* and the *magnetic flux density* in a finitely conducting magnetic region bounded by a plane $x+3y \le 6$ are 5 and $\vec{B} = 2\hat{a}_x + \hat{a}_y (T)$, respectively. If the other region is characterized by *free space*, find the $\vec{B}$ field in free space.

Problem 2 (20 Points)

The fields inside an *air-filled* coaxial line having inner radius *a* and outer radius *b* are given as $\vec{E} = \hat{a}_\rho \frac{V}{\rho \ln(b/a)} e^{j(\omega t - kz)}$ (V/m) and $\vec{H} = \hat{a}_\varphi \frac{I}{2\pi\rho} e^{j(\omega t - kz)}$ (A/m), where *V* and *I* are the peak values of the voltage and the current with an angular frequency of ω rad/sec, $\rho, \hat{a}_\rho, \hat{a}_\varphi$ are coordinate and unit vectors of cylindrical coordinates. Show that $k = \omega\sqrt{\mu_0 \varepsilon_0}$ and $\frac{V}{I} = \frac{1}{2\pi}\sqrt{\mu_0/\varepsilon_0}\ln(b/a)$ directly from *Maxwell's equations*. Note that in cylindrical coordinates, the curl of a differentiable vector $\vec{A}$ is given by

$$\nabla \times \vec{A} = \frac{1}{\rho}\left(\frac{\partial}{\partial \varphi}A_z - \frac{\partial}{\partial z}(\rho A_\varphi)\right)\hat{a}_\rho + \left(\frac{\partial}{\partial z}A_\rho - \frac{\partial}{\partial \rho}A_z\right)\hat{a}_\varphi + \frac{1}{\rho}\left(\frac{\partial}{\partial \rho}(\rho A_\varphi) - \frac{\partial}{\partial \varphi}A_\rho\right)\hat{a}_z .$$

Problem 3 (10 Points)

Prove that the *attenuation constant* of a *good* transmission line with distributed parameters *R*, *L*, *C*, and *G* per meter is approximately given by $\alpha \approx \frac{R}{2Z_0} + \frac{GZ_0}{2}$, where $Z_0 \equiv \sqrt{\frac{L}{C}}$.

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Problem 4 (20 Points)

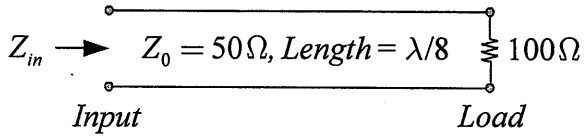
A $\lambda/8$ lossless 50-ohm transmission line is terminated by a resistor of 100 ohms as its load. Please find

(a) the *voltage reflection coefficient* at the *load*,

(b) the *voltage reflection coefficient* at the *input*,

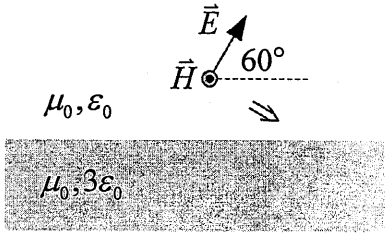
(c) the *voltage standing wave ratio* on the 50-ohm line, and

(d) the *impedance* Z_{in} at the *input*.



Problem 5 (10 Points)

A *plane* wave in air is *obliquely* incident on a dielectric medium with $\varepsilon = 3\varepsilon_0$ as shown. What is the *percentage* of its power got transmitted into the dielectric medium?



Problem 6 (20 Points)

In an *air-filled* rectangular waveguide, the cutoff frequency of a TE_{10} mode is $3GHz$, whereas that of TE_{01} mode is $4GHz$, calculate (a) the *dimensions* of the guide, and (b) the *guided wavelength* for TM_{11} mode at $5GHz$, if the guide is filled with a lossless material having $\varepsilon_r = 4$ and $\mu_r = 1$.